

Green Flight



Outline

- How much emissions are there from aviation (EU-perspective)
- What can Air Navigation Service (ANS) providers do?
- How to measure “green actions”, what is good and what is bad?
 - Environmental Key Performance Indicators.
 - The need for Trade-off studies.
- Conclusions

Aviation emissions

- Aviation is an unique emission source. Release primarily occur in the upper troposphere and lower stratosphere (8-12 km) on a global scale



Aviation emissions in European airspace

2009	Flights within EUROCONTROL area	Flights to/from EUROCONTROL area within / outside	TOTAL within EUROCONTROL area
Number of flights	~7,700 000	~1,700 000	~9,400 000
Average number of seats	123	220	153
Average Max Take Off Weight	63 t	203 t	94 t
Average Distance flown	900 km	1691 / 3039 km	1046 km
Average flight time	80 min	125 / 206 min	88 min
Fuel per flight	3.1 t	10.8 / 22.4 t	4.5 t
Total Fuel	23 000 000 t	19 Mt / 39 Mt	42 000 000 t
CO2	74 000 000 t	59 Mt / 122 Mt	133 000 000 t
%	56 %	44 %	100 %

Source: EUROCONTROL Performance Review Report 2009

Aviation fuel efficiency

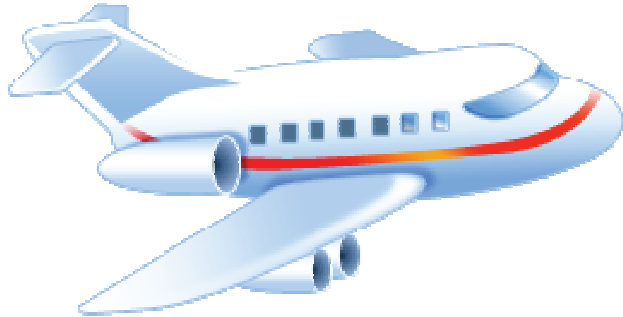
Airlines

Manufactures

Air Navigation Service

Load factor

Aircraft fuel efficiency



ANS fuel efficiency
Optimal vs. Actual trajectory

Inefficiencies actionable by ANS

2009	Fuel Flight	Fuel Total	CO2 Total	%
Estimated average within European airspace	4,5 t	42 Mt	133 Mt	100 %
Horizontal en-route flight path	163 kg	1,5 Mt	4,8 Mt	3,6 %
Vertical en-route flight profile	25 kg	0,2 Mt	0,7 Mt	0,6 %
Airborne Terminal	51 kg	0,5 Mt	1,5 Mt	1,1 %
Taxi-out phase	32 kg	0,3 Mt	0,9 Mt	0,7 %
Total	~271 kg	~2,5 Mt	~8,0 Mt	~ 6 %

Source: EUROCONTROL Performance Review Report 2009

Green actions from ANS acts on all aircrafts !

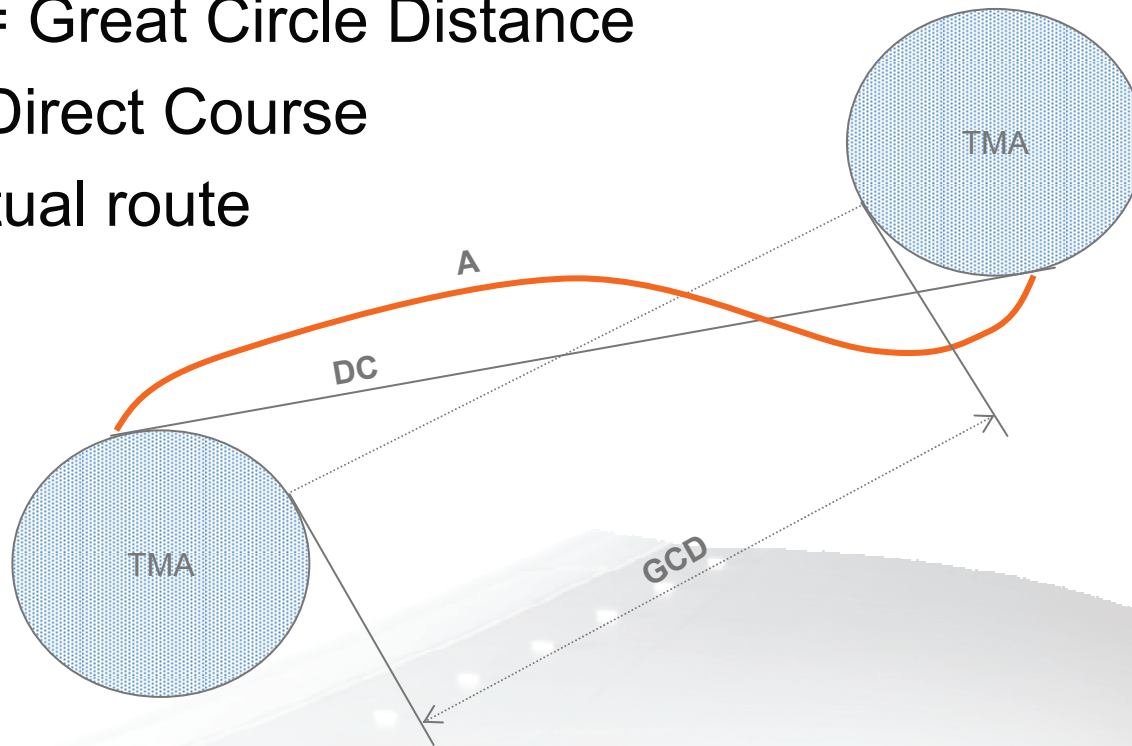
ANS ways of reducing emissions

- Airspace design
 - Free route air spacing (FRAS)
 - Arrival and Departure route design (STAR/SID)
 - Use of Precision Navigation procedures
- Arrival and departure manager (AMAN/DMAN)
- Continuous Descend Operations
- Better use of weather information
- Optimum use of Runways
- Timing and punctuality

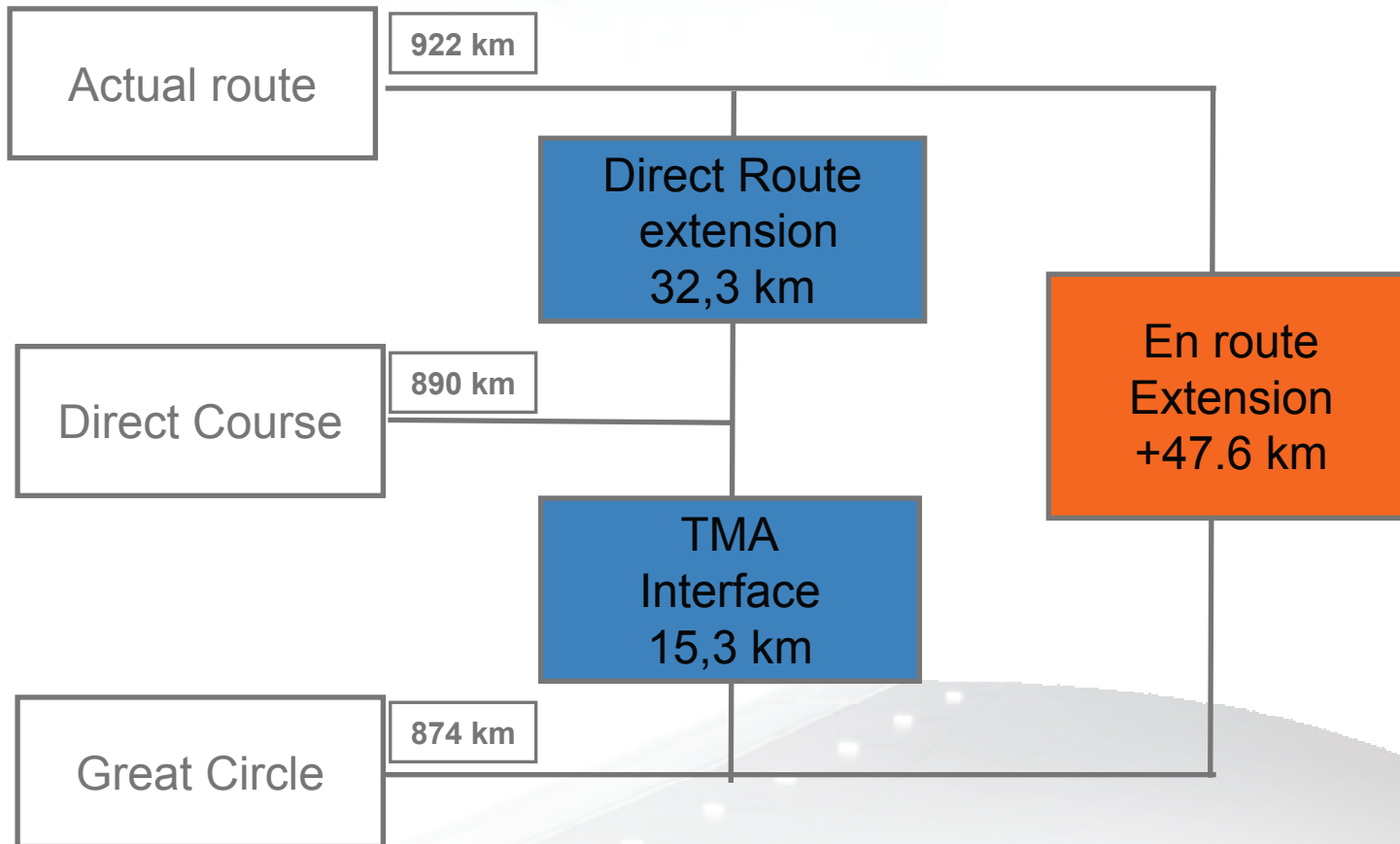


Measuring the “Horizontal flight efficiency”

- TMA = Terminal Manoeuvring Area, close to the airport
- GCD = Great Circle Distance
- DC = Direct Course
- A = Actual route

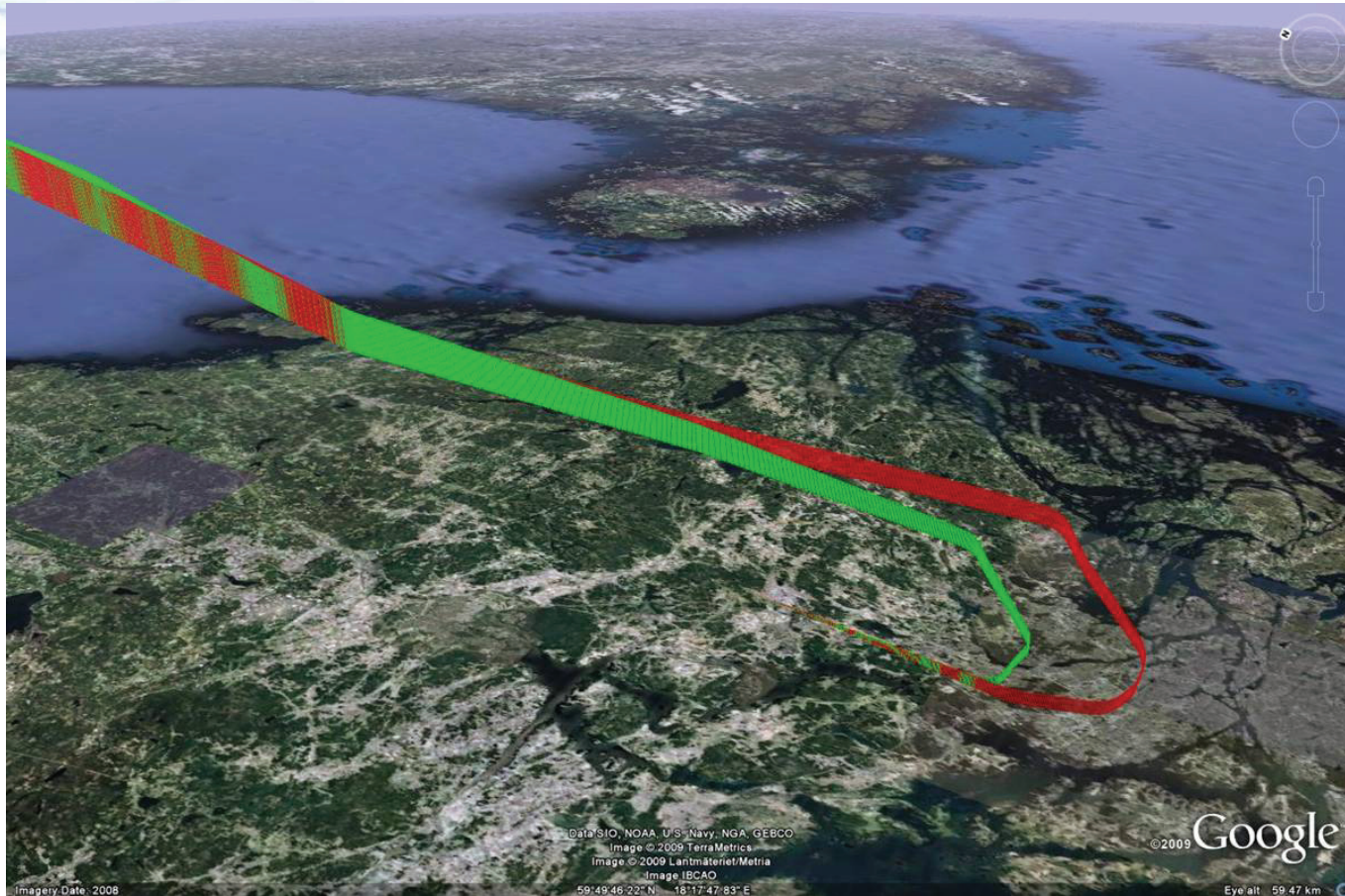


Horizontal flight efficiency in Europe today



Source: EUROCONTROL Performance Review Report 2009

Efficiency in Terminal Manoeuvring Area



One “green” CDA-approach compared with an non-CDA approach to Arlanda airport. Both are Boeing 737-600

Comparison between fuel and flown distance in TMA from FL95 to “gear out”

B737-600	BROWN	GREEN	DIFF
Flown Distance	89,4 km	54,9 km	34,5 km
Fuel used	276 kg	109 kg	167 kg

Source: Flight Data Records from the two flights

What are the problems?

- The European borders...
- Trade-off considerations
 - Safety versus Nothing
 - Capacity versus Environment
 - Emissions versus Noise
- How to measure what actual benefits there is from “green” actions taken in ATM?

How to measure potential benefits from operational procedure changes?

- Develop environmental Key Performance Indicators (KPI) based on data with high resolution in time and space.
- Build the KPI:s from ANS-systems since FDR-data very often is restricted for use.
- Radar-tracks archived in ANS systems are a good candidate as a data provider for environmental KPI:s.

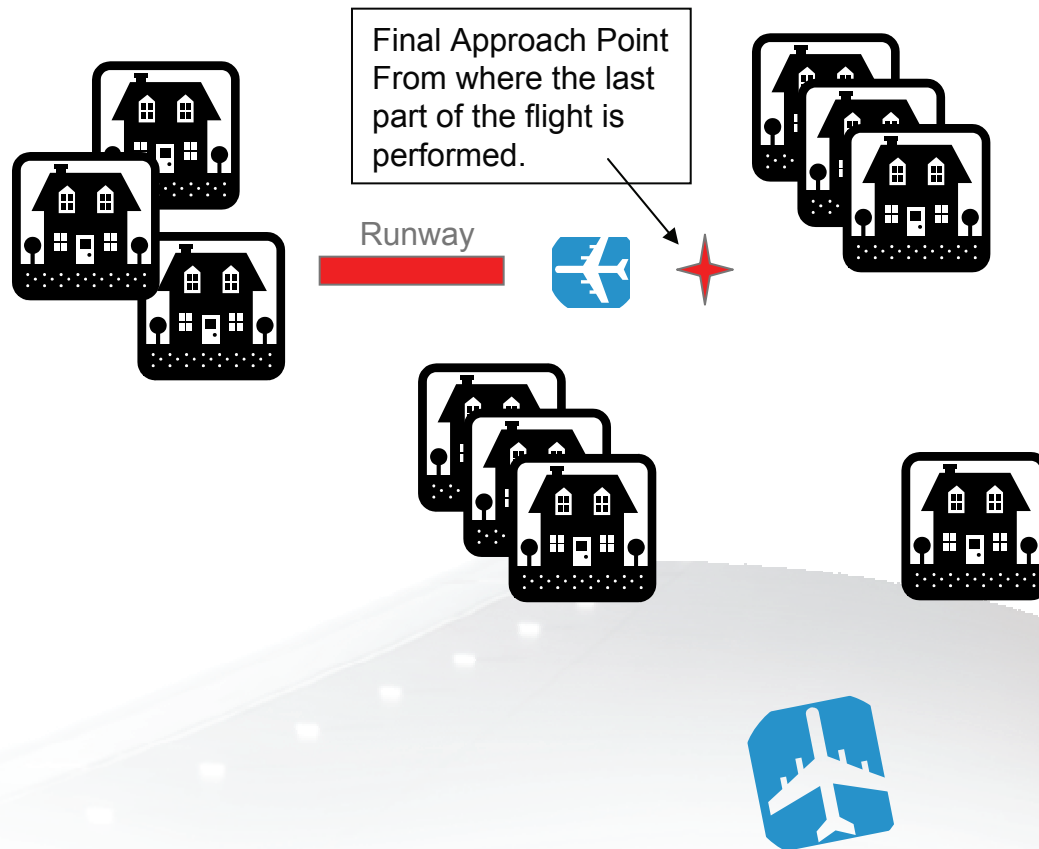
Environmental KPI:s

- Flown distance [nm]
- Excessive lateral flown distance [nm]
- Fuel consumption [kg]
- Excessive fuel consumption [kg]
- Number of CDA:s.
- Time in levelled flight [minutes] [%]
- Taxi time [minutes]

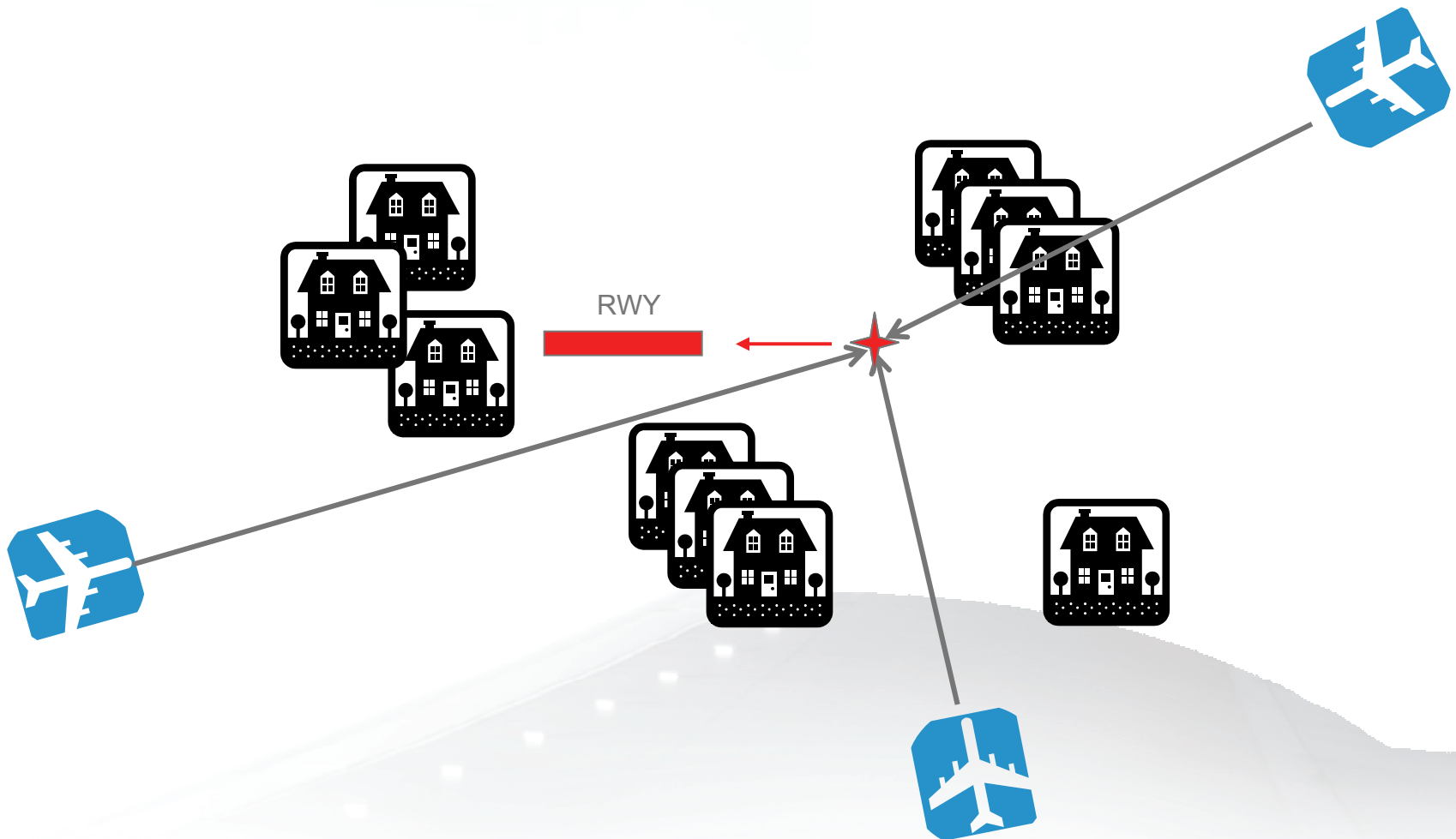
**all defined as an average per flight*

The above KPI:s are under implementation at Swedish ANS after FOI recommendations in the project “Green Business Case II” between LFV and FOI:
Project Team: Benny Jansson, Tomas Mårtensson, Björn Nevhage, Maria Stenström

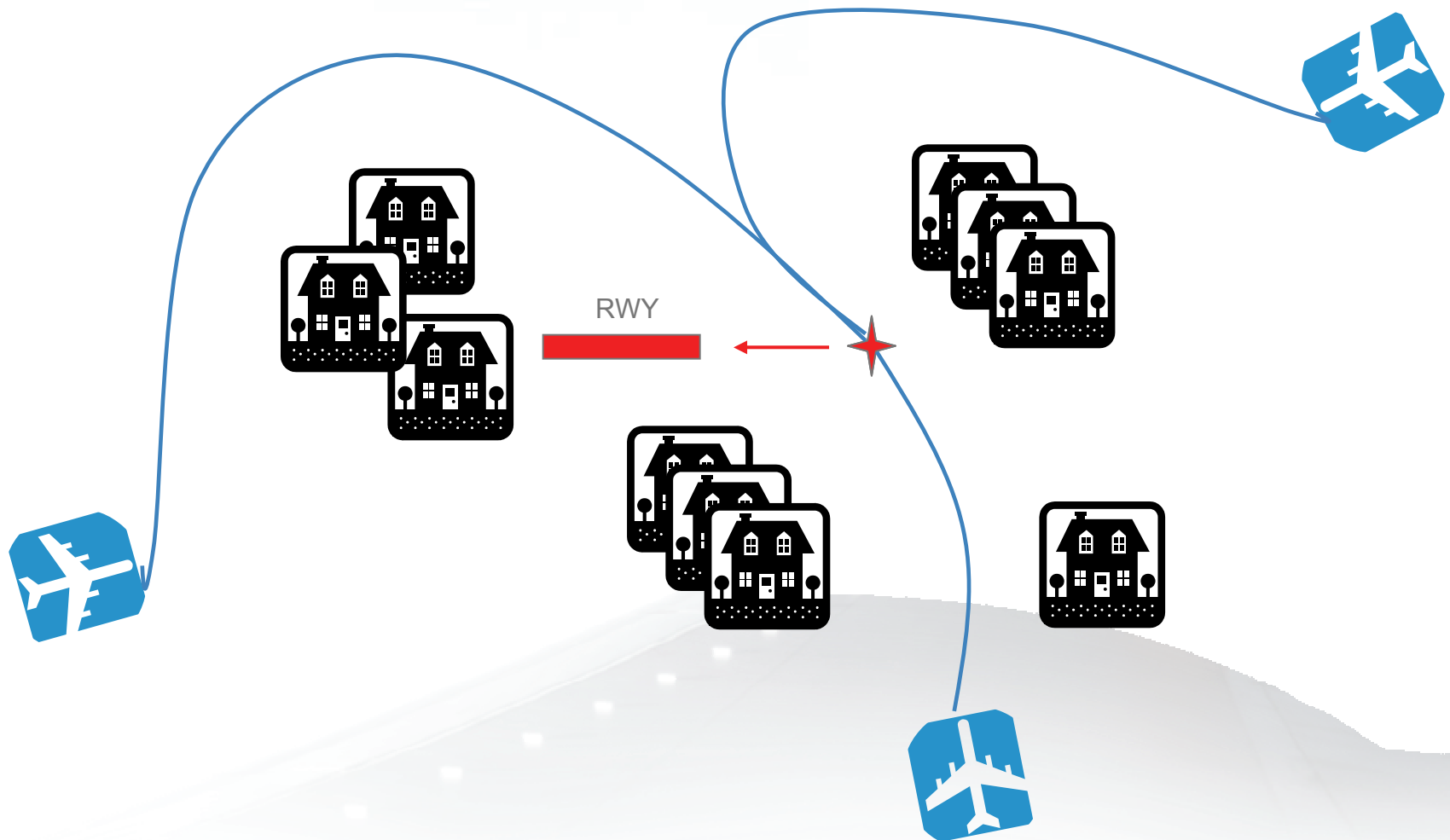
Trade off studies: Emissions versus Noise



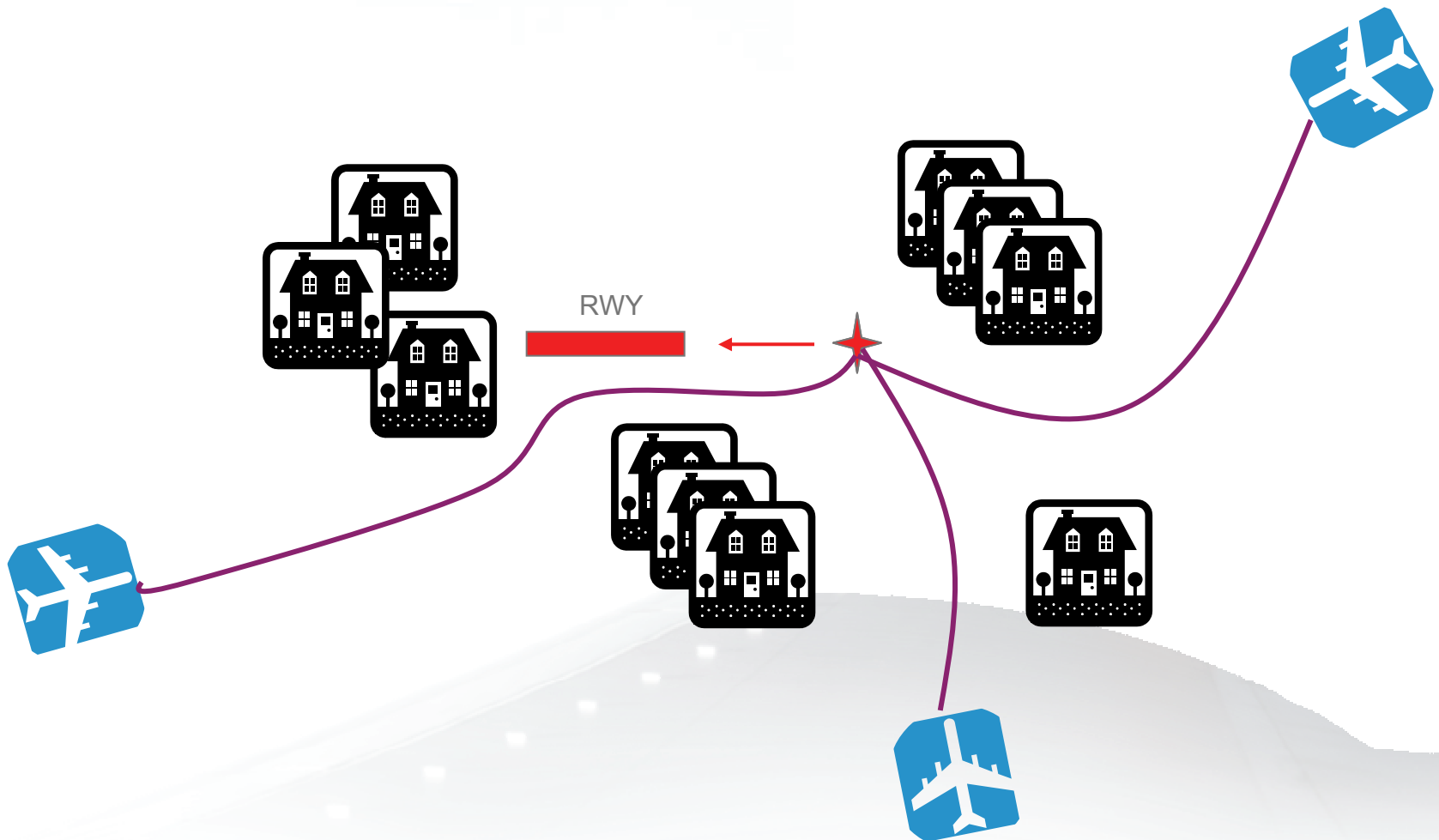
Lowest emissions = Direct Course



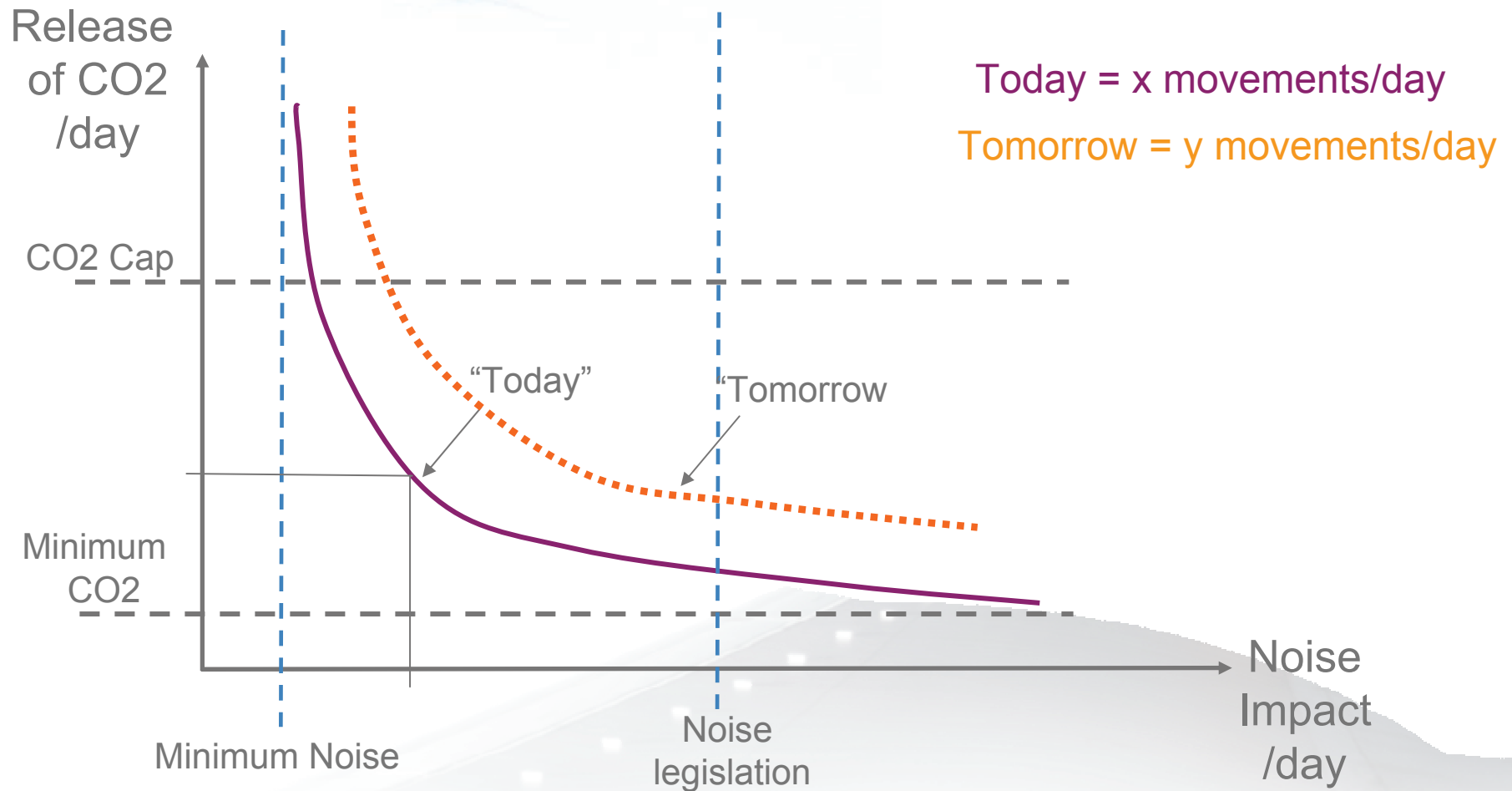
Lowest Noise



Real operations



Emissions versus Noise



Summary

- Last year 2009, ~44 Million tones of kerosene was burned within in EUROCONTROL Area (excluding sport & military aviation).
- ANS can act on ~6 % of aviation emissions (more for individual flights)
- There is a need for better measures (KPI:s) with high resolution in time and space to be able to quantify “green actions”
- As aviation grows, there is a clear need to put numbers on the trade-off between noise and emissions to meet future legislations.